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THESIS

MAINTENANCE REPORTING SYSTEMS
FOR ELECTRONICS SYSTEMS

by

Duane R. Velte

December 1978

Thesis Advisor: A. W. McMasters

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The REWSON project (PME-107) of the Naval Electronics Systems Command is concerned with obtaining maintenance information for its equipment in a timely and accurate manner. They want to identify and correct problems as they are developing rather than waiting until they become critical. This study reviews the available alternatives for obtaining maintenance information. It discusses the advantages and disadvantages of each and provides a recommended

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Maintenance Reporting Systems for Electronic Systems

by

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

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Abstract

The REWSON project (PME-107) of the Naval Electronics Systems Command is concerned with obtaining maintenance information for its equipment in a timely and accurate manner. They want to identify and correct problems as they are developing rather than waiting until they become critical. This study reviews the available alternatives for obtaining maintenance information. It discusses the advantages and disadvantages of each and provides a recommended course of action. The recommendations suggest that expanded use of the Fleet Reliability Assessment Program (FRAP) is the best alternative for analyzing an identified problem equipment, while the actual identification of problem equipment is best done through a coordinated use of the 3M system, supply demand data and casualty reports.

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I. Introduction

A. Background

" The 3M system does not provide the information that we need accurately or in a timely manner to adequately support our equipment. Do we need our own maintenance reporting system or is there one available to do the job without reinventing the wheel? "

The above statements are paraphrases of Captain H. M. Leavitt, Jr., of the REWSON Project (PME-107-1) of the Naval Electronics Systems Command (NAVELEX), Washington, D. C. This project procures and supports highly sophisticated equipment from cradle to grave; i.e., from design to procurement to fleet operation to withdrawl from service. This is unlike most electronic equipment program managers whose mission is usually completed subsequent to fleet introduction of the last equipment on a procurement contract. Normally then the item is managed by NAVELEX for the remainder of its life cycle. The primary reason for the difference between REWSON and other projects is that the life cycle of REWSON equipments is much shorter than most of the usual equipment managed by NAVELEX.

PME-107's concern for equipment it develops usually involves quickly correcting a situation which is adversely affecting the equipment's performance. The problem may be in engineering design, maintainability, or system supply support. The principal sources of information about such problems are the Maintenance Material Management (3M) central data bank,

Casualty Reports (CASREPTS), and direct fleet input.

The intent of the 3M system as originally designed was to provide equipment managers with maintenance information which would give early indications of developing problems. These would be expected long before CASREPTS or direct fleet complaints. However, as will be detailed later, experience with the 3M system has been unrewarding. Inaccurate and incomplete information, a long processing pipeline (as much as 12 to 18 months) and other factors make the data almost useless.

Once the problem is identified, it is necessary to perform an engineering analysis, decide on what corrective action is necessary, develop a plan of action and milestones and implement the action. If additional funds or equipment procurements are necessary, then there is the potential delay of the entire budget cycle and procurement leadtime before the fleet sees any action. This process could take as much as three or more years.

The entire elapsed time from the actual event to ultimate solution may take as much as five years! By this time the existing system may be obsolete! One way of reducing this time is to reduce the time now taken to notify PME-107 about equipment problems. That is what Captain Leavitt was alluding to in the first paragraph.

B. Another Dimension

While researching the various aspects of this problem, the author also explored what impact the rapidly changing

world of electronics has upon this problem.

The era of microminiaturization is upon us and moving at an incredible rate. " A 'generation' in the field of digital hardware is only about 15 months, bringing about significant changes in capability and cost." (5:58) It is anticipated that by 1980 an entire computer system will be on a single silicon chip, having thousands of words of core storage. Yet, the costs will be down to hundreds rather than the thousands of dollars of today. Even now, " at acceptable cost, we can build into an expendable missile more information processing capability than could be accommodated in a cruiser in World War II." (6:117)

Additionally, this new technology has led to built-in test capabilities in many electronics systems. This capability permits " rapid fault isolation in place and offers the potential for significant reductions in the time needed to restore these systems to service." (3:356)

Although these built-in test equipment are in fact microprocessors, they are not presently used to provide even basic maintenance reporting data. Reporting of mainentance actions is still being accomplished totally by maintenance personnel. As will be suggested later, the data preparation could be automated and accuracy and completeness of the data could be improved by using these processors.

II. Objective

The objective of this study is to determine the best possible method for PME-107 to receive maintenance data which will permit timely analysis of declining equipment performance as it is developing. PME-107 desires rapid visualization of problems before they become critical.

This study will be limited to shipboard electronic equipment only (aviation equipment is therefore excluded) since this study was prepared for PME-107 of the Naval Electronics Systems Command. However, there is no implication intended that the recommendations from this study could not be applied to other systems.

To reach this objective, the study will explore the following alternatives and determine the pros and cons of each.

1. Establish a specialized reporting system similiar to that used to study the AN/BRD-7 system by PME-107.
2. Rely on the 3M system.
3. Utilize Project Intercept.
4. Utilize the Fleet Reliability Assessment Program or similiar procedures.
5. Utilize the DART and/or the CASREPT programs.
6. Utilize supply demand data in lieu of maintenance reporting.

The study will then conclude with a comparison of the alternatives and will recommend a plan of action.

III. The PME-107 Study

The AN/BRD-7 is an electronic countermeasures and direction finding receiver used aboard fleet submarines and is managed by PME-107. Several years ago significant concern was raised that this equipment was not meeting the minimum specification of 500 hours mean time between failures (MTBF). Therefore, PME-107 established a program to collect maintenance data which could be used to determine the actual reliability and maintainability of this equipment. This data was to then be compared to equipment specifications and contractor data and corrective action was to be taken as necessary.

The program was designed to collect data for a six-month period and/or at least one deployment.

The objectives of this effort were:

(a) Determine AN/BRD-7 reliability in the fleet environment.

(b) Identify those areas where reliability problems were detected and those areas where potential reliability problems exist.

(c) Determine AN/BRD-7 maintainability characteristics in the fleet environment.

(d) Identify those areas which affect system maintainability.

(e) Report and record those characteristics which affect its overall effectiveness in such areas as human factors, technical manuals and logistic support. (9:2)

In addition, special reports were to be prepared for all corrective maintenance actions necessitated by "unsatisfactory system performance", including only those failures discovered:

(1) by maintenance personnel during a system check;

(2) by maintenance personnel during a routine or preventive maintenance action; or

(3) by operating personnel during normal system operation. (9:3)

Utilizing a specially designed form, the associated corrective maintenance actions were recorded by shipboard personnel and forwarded to PME-107's agent for analysis. Additionally, all throwaway parts were also forwarded for subsequent analysis.

After obtaining the concurrence and authorization of the Commander, Submarine Force, Atlantic Fleet (COMSUBLANT) in January, 1975, personnel representing PME-107 installed the data collection program on six designated platforms.

As a consequence of this effort and the corrective actions of the contractor, Sanders Associates, the MTBF was improved from below the equipment specification of 43% confidence up to a 73% confidence that the MTBF is not less than 500 hours as of September, 1977. (8:3)

This special reporting system did in fact achieve the desired results, but with some disadvantages:

1. PME-107 had to design its own forms.
2. PME-107 had to establish a reporting network.
3. PME-107 had to administer the program itself.
4. PME-107 had to analyze each report for relevance.
5. The reports required manual review, correlation, and summarization.

Some advantages were:

1. The program highlighted problems which could be analyzed and corrected expeditiously.
2. The program featured face-to-face liaison with fleet

personnel. The fleet actually saw the results of their efforts bear fruit.

3. The program reduced the information pipeline time.

IV. The 3M System

A. Background

The modern Navy is a far cry from the day of the sail. Advances in technology have created today's modern warships with very sophisticated and complex weapons systems. As these systems developed, a need also was developed for a standard and simple means of maintaining and supporting these systems. As a result, in January, 1963, George Washington University was assigned the problem by the Office of Naval Research. The result of their research was the Navy's Maintenance, Material Management (3M) system concept.

The emphasis of the 3M system is to:

- Standardize ships and aviation maintenance procedures.
- Collect maintenance data at its source once and only once.
- Collect data in a manner facilitating ADP (Automatic Data Processing)
- Make the Maximum Use of ADP Process in Analyzing Maintenance Data" (16:I-3)

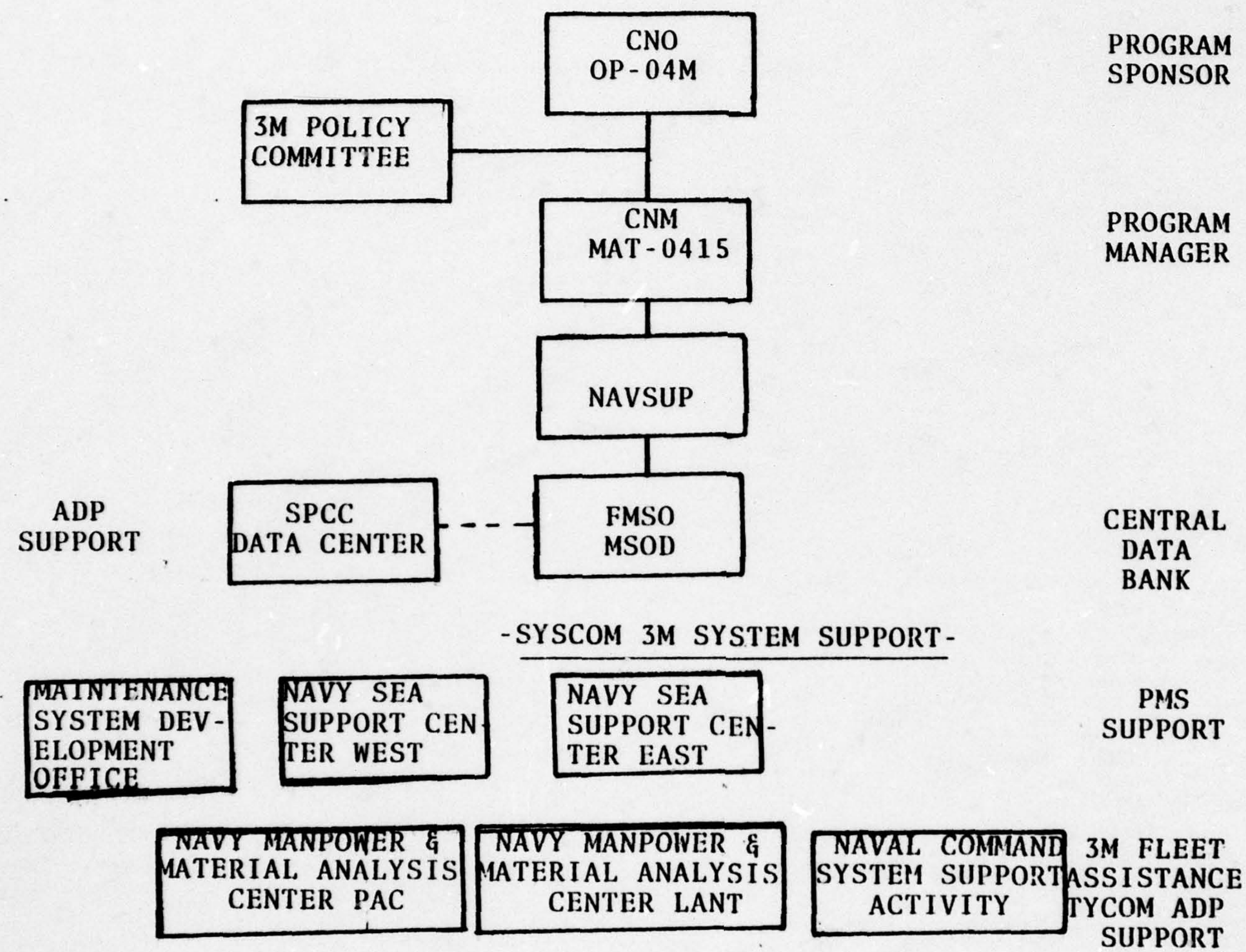
Figure 1 presents the basic 3M program organization responsible for operation of the maintenance reporting system. The activities which support the organization shown at the bottom are basically the data interface between the fleet and the central data bank. The actual data flow will be described later.

Figure 2 shows the basic shipboard 3M organization.

B. Program Description

The 3M system is divided into two subsystems. One is the Preventive Maintenance System (PMS) and the other is the Maintenance Data Subsystem (MDS).

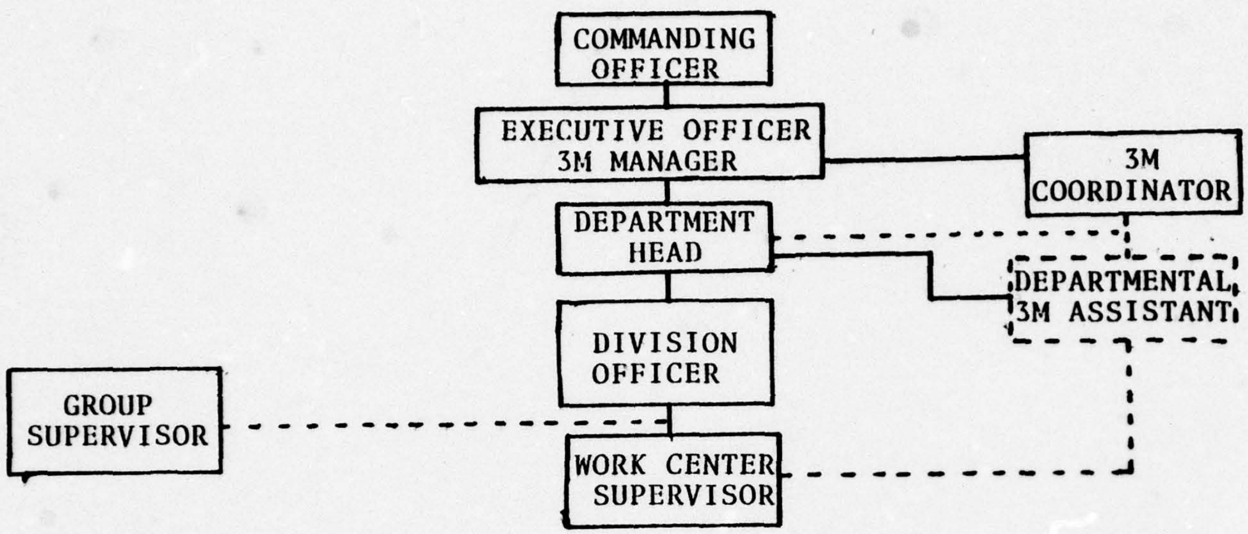
3M PROGRAM ORGANIZATION



(Reference 16: p. I.6)

Figure 1.

SHIPBOARD 3M ORGANIZATION



CONTROL FUNCTIONS ____________

COORDINATING ADVISORY FUNCTIONS - - - - - - - -

(Reference 16: p. I.7)

Figure 2

The PMS portion does not require system reporting. The only requirement is that the preventive maintenance actions be scheduled, completed, and recorded locally. However, a planned maintenance sub-system feedback report (OPNAV form 4790/7B) should be submitted by the local command to recommend improvements, recommend safety precautions, report errors, replace materials, and request that some action or equipment be included in the PMS. These reports are submitted to the type commander or Navy Maintenance Management Field Office. Type commanders are responsible for performing inspections of local records to ensure PMS actions are being performed. (16:I.17-I.18)

The Maintenance Data System is the sub-system which reports corrective maintenance actions. It is through this sub-system that manhour, maintenance performed/required, and parts usage data are collected. (16:I.24) Two of these, labor and narrative data, are reported on a Ship's Maintenance Action Form (2-KILO) Parts data is recorded on a consumption management document (NAVSUP form 1250) or a requisition document (DD form 1348).

The 2-KILO forms are forwarded to the supporting ADP facility as designated under the Intermediate Maintenance Activity Management System (IMMS), usually a tender. Here the manual maintenance action forms are processed and output on magnetic tape. These tapes are then forwarded to the appropriate Data Processing Service Center (DPSC), either Atlantic (LANT) or Pacific (PAC). The tapes are forwarded to

the Maintenance Support Office Department (MSOD) of the Navy Fleet Material Support Office (FMSO). Finally, they are input to the central data file stored on the Ship's Parts Control Center's (SPCC) computer. There are, as usual, exceptions to the above procedure. All aircraft carriers and selected shore activities submit their maintenance tapes directly to MSOD.

The repair parts data information is forwarded separately to MSOD via the DPSC's by all ships.

Unfortunately, maintenance reports are not submitted on all equipment for every corrective maintenance action. The determination of whether an action is reported or not is quite complicated and is based on the type of maintenance action.

There are three types of corrective maintenance actions. First, a non-deferred maintenance action is one which is initiated and completed by the originator (ship's force) without deferring it. This type must be reported by all cruisers and submarines. Additionally, designated ships must report this action for those equipment on the Selected Equipment List. (19:4) The Selected Equipment List encompasses approximately 500-600 of the Navy's 11,000 equipments. (20)

Second, there is the deferred maintenance action. All ships must report this type of action. A deferred maintenance action includes all actions which:

- Require some type of assistance from activities external to the ship.
- Are not expected to be accomplished by ship's force personnel within 30 days (or other time

frame prescribed by the type commander).
-Describes uncorrected deficiencies reported by an Inspection and Survey Team (INSURV). (19:4)

The third type of action involves the issue of repair parts in support of maintenance. All ships are required to report those parts used in support of maintenance regardless of the type of maintenance action. (19:4)

This abbreviated procedure was the result of Admiral Zumwalt's efforts to reduce shipboard workload. Prior to his decision, all maintenance actions, including preventive maintenance actions, were reported by all ships.

C. Disadvantages

The 3M system has some serious shortcomings as PME-107 found out when they attempted to correlate their own data with 3M system reports.

Since the AN/BRD-7 was on the Selected Equipment List, PME-107 attempted to correlate 160 of their failure reports with the associated 3M data. The results of the comparison are presented in Table I. A "relevant failure", as used below, means a failure of the type reported in the PME-107 study described in Chapter III.

	PME-107 Data	3M Data
Operating Hours	88671	N/A
Relevant Failures	160	76
MTBF (in hours)	555	?

Table I.- PME-107 data versus 3M data

Some of the 3M reported failures were not relevant to the study (such as equipment down during ship alteration,

readiness check performed or other such inapplicable information). Additionally, only 38 of the 76 3M relevant failures correlated with the 160 relevant failures reported to PME-107.

Mean time between failures (MTBF) could not be calculated from the 3M data, since 3M does not record operating hour figures.

Finally, the basic data in the 3M reports had errors. Incomprehensible manhours expended figures were reported. For instance, thirty-four antenna failures only showed a total of three manhours expended to repair. Equipment serial numbers were inaccurately reported. For instance, serial number, A3, was reported in fifteen incorrect ways, including A-3, 3A, AN/BRD-7, 1, one, none, and others. Some reports were ludicrously inapplicable. These included improvements to crew mess habitability, inadequate spares, and others.

Another problem of the 3M system is its timeliness. As an example, in June 1977, of the shipboard maintenance actions received at MSOD, only 18% were less than 30 days old. In comparison , during the same month 42% of the aviation maintenance actions received were less than 30 days old. Yet the number of transactions for the aviation community was 5 times greater than the shipboard community. (17)

D. Improvement Efforts

What is being done to relieve some of the problems highlighted above? The principal coordinated effort is the Ships' 3M Improvement Program (SMIP). SMIP is managed by the 3M policy committee in the Office of the Chief of Naval Oper-

ations (OPNAV). (See Figure 1.) This program is a collection of projects being managed by several of the Naval Material systems commands, monitored by the policy committee. (14: Introduction)

One of the SMIP improvement efforts attempted by the Naval Sea Systems Command (NAVSEA) was the Partial Source Data Automation (PSDA). The objective of the program was to simplify shipboard maintenance reporting still further and yet to improve the accuracy of data provided by the maintenance man.

PSDA uses plastic cards similiar to oil company credit cards. These cards include fixed equipment identification data elements, such as equipment name, allowance parts list (APL) number, serial number, location, etc. The cards are used with a mechanical imprinter machine to print card data on an automated maintenance action form (OPNAV 4790/2Q). Additionally, the PSDA printer can input several categories of variable data through the changing of manual levers. hese categories include "when discovered", "status", "cause", and others. (16: I.33-I.34)

The idea has merit, but MSOD personnel indicated that of those ships equipped with the cards only sixteen percent of their maintenance action forms utilize the "automated" equipment. When asked why, they indicated that on most ships the PSDA cards and imprinter are maintained in a central location. Thus, when most personnel do the required maintenance, they prefer to fill out a manual 2-KILO form in their work space

and submit that report rather than going to the PSDA equipment.

Unless many nore imprinters are installed, PSDA appears to have failed to solve the problem that it was developed for.

Other topics currently under study in SMIP include "3M System Reorganization", "Minimize Planned Maintenance Requirements", "PMS Training", and the "Maintenance Data System". The latter is by far the largest portion of SMIP and PSDA is actually a part of it. Other components of it are "Depot Level 3M Procedures", "Improved Management Reports from MSOD", "ADP Support for Organizational Level Ships", and "Project Intercept". (To be discussed later.) (14:Index)

Even though many areas of 3M are being reviewed and studied, the ultimate resolution and relief for the fleet is years away. For instance, the "ADP Support for Organizational Level Ships" project is considered critically behind schedule by the 3M policy committee. It involves the development of a mini-computer for operational fleet units. The software is currently under development. The first unit will not be installed until 1979 aboard the FFG-7 class ships. Because of budgetary requirements and approval requirements of the Brooke's Congressional committee for all computer procurements, complete fleetwide installations is years away.

E. Advantages

The 3M has several significant advantages:

1. The 3M data bank is better than nothing! It contains a great deal of valuable data readily available.

2. The system is established and understood by the fleet. There is no new learning curve effect and no administrative development necessary.
3. Improvements are underway which should have significant impact on solving its problems in the long run.
4. The 3M data bank is mechanized and very flexible. The variations of reports available are almost limitless. There are 38 standard reports with many options for each report. (20) Additionally, special reports can be developed if feasible. (16:II.8) The system through these reports performs a "filtering" function Filtering reduces "unneeded or irrelevant data being accepted for processing or being output." (3:108) This reduces the need for the manager to review all reports as the PME-107 study required.

V. Project Intercept

A. Introduction

Although a vast amount of data is being input to the 3M central data bank, there is comparatively minimal use being made of the information. Only eleven monthly/quarterly recurring reports to fifty-six customers are output as ships 3M information reports. This is approximately twenty percent of the number of similiar reports output for aviation 3M reports. (17)

Why are the reports not used? With the multitude of tasks facing the manager aboard ship, he requires reports that will help him do his job better. In fact, the manager needs to "be concerned only with deviations outside allowable control limits." (3:133) This translates into a requirement for exception reports that highlights his problems.

Ships' 3M information reports, which must be ordered from the Maintenance Support Office Department (MSOD), do not provide such information. These reports are simply consolidations of all data. There is no attempt to highlight exceptional data. Thus, the shipboard manager, trying to decide which report to use, does not know which report will in fact provide him with the most useful information.

With that spirit in mind, a Chief of Naval Material policy statement in 1973 directed that the 3M system be extended to actively "push" information to appropriate Naval Material Command managers when potential problems were indicated. As a result, Project Intercept was established in

1974. (15:3)

B. Program Description

Project Intercept uses the following procedures:

1. Establishes equipment performance standards.
2. Utilizes the Maintenance Data System to measure equipments' Reliability, Maintainability, and Availability and parts support against these standards.
3. 'Pushes'problem equipments to cognizant action activities.
4. Monitors remedial action taken.
5. Feeds back progress to the fleet. (16:IV.4)

The equipment performance standards or indicators are command specified measures of performance. They include Mean Time Between Corrective Maintenance Actions, Mean Time to Repair, Mean Down Time, Availability, and Number of Safety Maintenance Actions. The specified level for each standard is compared to the actual fleet average utilizing a significant difference test. If the test indicates a difference, then the equipment is "intercepted" and reported to the cognizant authorities in a Report of Intercepts. (13:Encl.(1),p.3)

The Report of Intercepts is published twice a year on 30 August and 28 February. (13:Encl.(1),p.11)

The followup report to the Report of Intercepts is the Intercept Monitor Report. This report specifies the action activity "to investigate, confirm, or dismiss and, if needed and feasible, take action to resolve the suspected problem." (13:Encl.(1),p.4) It also includes a status report on action taken. The Intercept Monitor Report is also published twice a year on 30 November and 30 May. However, action activities must report their initial response within sixty days sub-

sequent to the publication of the Report of Intercepts. (13: Encl.(1),p.11)

C. Program Status

Project Intercept has been plagued with problems. The problems are concentrated in two areas: (1) Measurement of equipment performance and (2) System command actions on Potential Problems Reports (PPR) which are the critical portion of the Report of Intercepts.

The problems in the measurement of equipment performance result from inadequate funding and maintenance data system deficiencies. Inadequate funding from the hardware systems commands has limited the number of performance indicators that have been calculated. To date, only about 100 of the approximately 540 equipments in Project Intercept have performance indicators developed.

One of the principal maintenance data system deficiencies is that the 3M data base is not complete enough for Intercept's essential computations. For instance, 3M does not record equipment operating time as was discovered by PME-107. MSOD must perform a manual effort to analyze the data and to draw essential data from other sources. This method relies heavily on estimation techniques which cause a loss of accuracy and credibility. "This contributes to resistance by the technical community to use of the data as a valid basis for measurement of equipment RM&A (Reliability, Maintainability, and Availability) and for problem identification. This underlying attitude about MDS data analysis and use may be

at the root of much of the inadequate responses from the technical community on Intercept PPR's." (15:18-19)

The second problem area deals with system command response to PPR's. Much of the work of analyzing the reports are performed by industrially funded activities. These activities are not adequately funded for the analysis effort. Therefore, the analysis is not done or, at the very least, delayed. There is no coordination between the hardware commands and the Naval Supply Systems Command (NAVSUP) concerning the same equipment. There have been reports which cited a parts problem while NAVSUP independently concluded that it was not a parts problem. Also the Intercept Monitor Reports have been superficial and infrequently updated. (15:20-21) Thus, this potentially valuable program has been floundering in a sea of funding deficiencies, confusion, incredibility, and non-support.

In summary, the advantages of Project Intercept are:

1. Project Intercept provides exception reporting. It alleviates some of the manager's problems of data review.
2. Minimal investment is involved, since the system is in operation. Only the development of the indicators requires funds at the beginning.
3. Project Intercept looks at those engineering areas that provide the best measurement of performance.

The disadvantages are:

1. Project Intercept depends on the 3M system for its data. Therefore, it has the same disadvantages as the 3M system.
2. Apparently none of PME-107's equipment have paramenters developed in Intercept.
3. Inadequate funding both for the development of standards and for subsequent analysis have reduced the program's effectiveness.

VI. Fleet Reliability Assessment Program (FRAP)

This program is a failure reporting, analysis, and corrective action system for NAVELEX electronics newly introduced to the fleet. (10:1-1) The program uses the existing 3M procedures augmented by special FRAP requirements. The objective of FRAP is to identify reliability, availibility, and maintainability problems as soon as possible after the fleet introduction of the equipment. This is done to take corrective action under contract warranty provisions and/or before production is complete on the first follow-on equipment.

The program is limited to:

a. no more than 20 equipments at any one time.

b. equipment of systems with critical fleet applications.

c. anticipated large populations. (11:1)

The program does not analyze all data from the fleet population. Instead, FRAP gathers data from a selected sample utilizing statistical sampling techniques. Once a platform, ship, has been selected, FRAP personnel visit the ship to give shipboard personnel training on how to fill out the additional data needed. The program uses the standard Ships Maintenance Action Form (2-KILO) with additional data added. The 2-KILO is distributed normally except that one copy is sent to either the West Coast or East Coast FRAP data collection activity. Additionally, when possible all throwaway modules removed and replaced are sent to the data collection activity for analysis. (2:2-3)

After six months or so of data collection, FRAP analyzes all the fleet and depot level repair data and a final report is published for distribution to interested activities by the activity assigned the analysis responsibility. The report summarizes the situation found and, if appropriate, recommends corrective action. It should be emphasized that, since the program is aimed at new deployed equipment and not simply problem equipment, the report may, in fact, find that the equipment is operating well and even exceeding specifications. (5)

Program limitations are due principally to funding restrictions and available capacity of the managing office (ELEX 4702) to analyze the data. Currently, competing priorities in NAVELEX have so limited the funds allocated to FRAP that the present program includes only six equipments. (5)

In summary, some of the program's benefits are:

1. Identifies problems while the contractor is still responsible for its performance.
2. Identifies actual operating failure rates which can then be used to update on-board spare parts allowances.
3. Motivates the contractor to perform in-house failure analysis.
4. Identifies inadequate specifications and testing requirements.
5. Decreases special reporting and improves 3M data quality.

Its disadvantages include:

1. Limited program due to funding constraints.
2. Presently looks at only newly deployed equipment.
3. May only result in confirmation that the equipment is operating satisfactorily.
4. Statistically random error is possible since it does not look at all data. This could mean that a problem is identified by FRAP sampling techniques that really is not a problem at all. Although remote, this could result in a misallocation of valuable resources.
5. Requires the manual analysis of individual maintenance action forms.

VII. DART and CASREPT Programs

A. Detection, Action, and Response Technique (DART)

> The objective of the DART Program is to identify the fleet's material readiness problems and provide the management attention, resources, and direction necessary to correct each problem through achievement of the equipment/system design requirements. (12:1)

Established in October, 1970, to improve fleet support, the DART program is limited to the "fleet's most serious material readiness problems." This is to "insure concentration of management and resources needed for resolution." (12: 2)

The program deals with all phases of the problem area. It reviews reliability, maintainability, design, usage, logistics support elements, training, manning, and documentation. It coordinates these diverse areas into unified plan of action and milestones including funding resources.

It is intended to be a remedial program. It handles those problems which have already caused significant material readiness degradation. Therefore, it will not respond to the problem of PME-107.

B. Casualty Reporting System (CASREPT)

> The Casualty Reporting System.....provides a timely method for reporting equipment failures and the effect of these failures on the capability of the reporting unit to perform its assigned mission(s). (18:v.)

The individual casualty report identifies a problem on the individual ship. As such, these reports do not provide the trend information essential to PME-107 analysis. However, casualty reporting is the quickest source of information about a previously unknown problem. CASREPTs are sub-

mitted by Naval message to all activities in the ship's chain of command including the appropriate hardware systems command. Therefore, all CASREPTs concerning PME-107 equipment can be a valuable source of information.

Again this system, like DART, deals with equipment which tends "to reduce the combat readiness of the Navy". (18:v.) These are not routine corrective maintenance actions. CASREPTs represent a failure of corrective maintenance actions. Although the data does not follow all maintenance actions, it can provide data needed by PME-107 earlier than concurrent 3M reports on the same equipment.

> The Navy Fleet Material Support Office (FMSO)
>
> has been designated as the focal point for the collection of data from CASREPTs submitted by all afloat units. The data collected is utilized in the production of various summary and informational reports.... (18:v.)

There are 42 different reports with many reports having optional data elements. Recurring reports may be requested via the chain of command to FMSO. (18:i-ii)

If an equipment is experiencing increased CASREPT activity, this system is useful in consolidating that data to facilitate analysis. This would be especially useful for depot level repairables. Consolidated CASREPT data could reveal a number of problems:

a. A shortage of system spares;

b. A shortage of carcasses to repair;

c. Extended leadtimes to procure spares; or

d. Unexpected increase in demand, because of incorrect projection of mean time between failures.

In summary, the advantages of the CASREPT system are:

1. CASREPTs are the most rapid and timely source of information on previously unknown problems.
2. Reports are available which consolidate CASREPT data to facilitate analysis.
3. CASREPTs provide information on a number of other problem areas, such as supply support, personnel, training, etc.

The disadvantages are:

1. CASREPTs report only critical unresolved failures.
2. CASREPTs can be random with little or no definite trend.
3. These limitations necessitates further data collection and analysis to determine sources of the problems.

VIII. Supply Demand Reporting

Another alternative for gathering information about PME-107 equipment is to utilize supply demand data from the Master Data File of NAVSUP's Uniform Inventory Control Program (UICP) to highlight those equipments experiencing increased supply requirements. The NAVSO P-1500 guarantees the use of these inventory control programs to anyone in the Navy.

In view of the above, there are areas that should be of interest to PME-107:

1. Demand data- The weapon systems file in UICP has a record of every installed stock-numbered part on each ship and also contains the interrelationship between weapons, systems and subsystems all the way down to the individual parts. Increased demand of parts may possibly be caused by the increased requirement for those parts by the equipment. Since increased parts usage implies increased equipment failures, supply demand can be used to highlight those problem equipment

2. Depot Level Maintenance Information- Presently, the 3M system does not report depot level maintenance; expansion to include depot level is part of the Ships' Maintenance Improvement Program described in Chapter IV under Improvement efforts for the 3M system. However, the supply system presently collects data in the three following areas which could be of use to PME-107:

a. Carcass return rate

b. Repair survival rate

c. Repair turnaround time

By "carcass return" is meant the return of not-ready-for-issue (NRFI) equipment, which must be repaired prior to re-issue. The supply system gathers information on these return rates to determine if enough carcasses are being returned to satisfy existing or projected supply demand. If the return rate is less than 100%, then the total number of available spare equipment is diminishing. Knowledge in this area could highlight a number of problems:

(1) The fleet is ignoring turn-in procedures.

(2) The equipment should not be classified as a turn-in repairable. The equipment may usually be beyond economical repair prior to turn-in and actually irreparable.

(3) Equipment is being lost in the system by improper handling, errors in procedure, or incorrect shipping instructions.

Repair survival rate is the success rate of the depot in repairing returned NRFI equipment. A survival rate of 75 percent indicates that 75 out of every 100 returned NRFI equipment can be repaired. Changes in this rate, especially a decline, could indicate equipment problems that require engineering analysis.

The repair turnaround time is the time from the beginning of a carcass' repair until it is repaired and returned

to the supply system in "ready-for-issue (RFI)" condition. Here, too, significant changes to this time could indicate a number of problems:

(1) Lack of repair parts.

(2) Lack of trained personnel to repair the equipment.

(3) A problem that requires engineering analysis.

In summary, the advantages of using supply system data are:

1. The data is timely and readily available.
2. The supply system routinely collects information about depot level repair.(The 3M system does not.)
3. Reports can be obtained which consolidate the data to facilitate management analysis.

The disadvantages are:

1. Supply data cannot provide maintenance data needed for engineering analysis of component failures.
2. The data only provides an indication of a possible problem. A problem may not even exist.
3. Additional data gathering would be necessary before serious engineering analysis could begin.

IX. Discussion

This thesis has presented a number of alternatives for gathering maintenance information. All of the alternatives will require additional funds to finance the analysis of the collected data, but the extent of such costs is not known at this time. The following discussion will therefore concentrate on comparing the advantages and disadvantages of the data collection capabilities of these alternatives.

For instance, designing a specialized reporting system guarantees that, if executed properly, PME-107 will receive the information it requires in timely fashion. To achieve this, however, a great deal of its own resources in men, money, and time must be expended. Having a special reporting system for each equipment or even one for all would probably be financially prohibitive.

On the other hand, if the 3M system was timely and accurate, it would be ideal for the job. Unfortunately, as shown, it is neither timely nor accurate. The 3M system is under intensive study and improvements are coming. Until then, an interim procedure is appropriate.

The DART program, as discussed, does not provide a solution to PME-107 problem. In fact, in terms of timeliness and early detection of developing problems, it is inappropriate to the basic task at hand.

The CASREPT system, however, can be useful. It is the quickest source of information about potential problems. The system is in being and operating which minimizes financial

investment in the administrative development of a system. Although the system does not provide the possibility of analysis of the trend of maintenance data, it does highlight equipment which are, in fact, having problems. Once identified, further data collection and/or analysis is necessary.

The use of supply demand data has one significant advantage and one significant disadvantage. Its advantage is that it is readily and rapidly obtainable, requiring minimal financial investment. The data is very timely due to the fact that the system is very mechanized and accurate, including its communication channels. Its disadvantage is that, like CASREPTs, it cannot be used exclusively. It only provides an indication that there might be a problem, because of some significant changes in the supply data.

Project Intercept was designed to provide the exception reporting that would be invaluable to PME-107. It was also designed to utilize 3M data as its source of information. That is not to say that it should, therefore, be ignored. Although 3M is incomplete, there is still valuable data available and it should be used to the greatest extent possible. The system is set up and operating and, therefore, requires minimum expenditure of funds.

Finally, consider the Fleet Reliability Assessment Program (FRAP). Basically, FRAP is between a specialized reporting system and the 3M system. It utilizes standard forms which are augmented with desired data, minimizing learning curve effects. It presents a "face to the fleet" and is

recognition that action is, in fact, on going concerning some equipment. It does not attempt to gather all data but uses sampling techniques, thus, reducing time and money. It is a time limited study, which also expedites the analysis and facilitates an early resolution of the problem. It was originally designed as a special program examining new equipment being introduced into the fleet. However, it is being looked at for using its techniques on older equipment. (5) Although it uses the existing 3M system, it does require some financial investment by PME-107 for the establishment of the reporting network. Funds are needed to finance the visits to the fleet units and to fund the data collecting activity. In spite of the funding requirement, FRAP techniques seem to provide the best alternative to meet PME-107's objective.

The use of FRAP techniques still does not provide the actual identification of those equipment to be studied. In this respect none of the individual alternatives provides the answer. Therefore, the recommendations presented in the next section consolidate the best parts of several alternatives which could work together to provide that answer.

X. Recommendations

The recommendations below are divided into short term and long term; the short term covering up to 10 years into the future and the long term going on beyond this 10 years.

A. Short Term Recommendations

1. If possible, ensure all existing and future equipment are included on the Selected Equipment List of the 3M system.
2. Establish Project Intercept parameters for all existing and future equipment as soon as possible. This will at least ensure that the thresholds of interest are established and recognized by all concerned.
3. Closely monitor CASREPTs to provide possible candidates for follow-on analysis. Cross check CASREPT demand data with supply system data for correlation.
4. Establish liaison with the Naval Supply Systems Command, the Navy Fleet Material Support Office, and the Ships Parts Control Center to determine the procedures for obtaining reports of supply demand data and data on carcass return rates, repair survival rates, and repair turnaround time.
5. Establish a schedule of 3M review for PME-107 equipment. Do not expect 3M to be 100% accurate. If an unfavorable trend is observed, use FRAP techniques to investigate. Provide feedback periodically to the fleet, including individual ships. Do not wait until the investigation is complete. Publish the

schedule of the 3M reviews to the fleet commands, especially to those commands with the appropriate equipment installed.

6. For existing systems, utilize FRAP statistical sampling techniques when analyzing equipment trends. This prevents excessive workloads and time required to obtain data while providing minimum chance of error.
7. For future systems, request that they be included in the Fleet Reliability Assessment Program (FRAP). Budgeting for FRAP within the procurement budget will add more emphasis and priority to FRAP than if it has to stand alone.
8. Establish specialized reporting systems only for those equipment that continue to be a problem after exhausting the above efforts. Such reporting systems should be short term to avoid conflicts with the implementation of 3M system improvements.
9. Like FRAP, close liaison with the fleet is essential. For those studies undertaken, PME-107 personnel visit the ships and provide feedback even if it is negative. It is further recommended that PME-107 address a letter to all ships which have PME-107 equipment installed. This letter should emphasize PME-107's concern with the quality and timeliness of 3M reporting and request support of fleet personnel in properly preparing and submitting maintenance reports. Emphasize PME-107's sincere intention to be responsive

to fleet problems. This will provide incentive to personnel that their efforts are not being ignored.

B. Long Term Recommendations

Within 5 to 10 years, the introduction of microprocessors should facilitate the collection and dissemination of maintenance data, minimizing or perhaps eliminating PME-107's current problem.

Microprocessors are now being developed for fleet use. PME-107 is, in fact, introducing microprocessors in their new equipment as built-in maintenance modules (i.e., test and fault isolation equipment). The Naval Sea Systems Command (NAVSEA) is also developing a shipboard non-tactical management information system (MIS), which contains a microprocessor. Therefore, it is logical that the maintenance modules and the ship MIS be integrated.

The integration of these equipment could decrease the present error rate evidenced in the 3M system. The PME-107 built-in test equipment could be programmed to prepare the basic maintenance reports. The report could then be transmitted to the ship's MIS computer for consolidation with other ship's maintenance data. The data could then be transmitted by radio or by tape to MSOD directly.

PME-107 and NAVSEA should work together to get the maintenance data relayed through the MIS to the 3M system or to PME-107 automatically as outlined. Therefore, PME-107 should establish a liaison with NAVSEA to determine the impact of the development the new non-tactical micro-computer systems,

including SNAP II, on the timeliness, accuracy, and completeness of the maintenance information needed by PME-107. Topics to be explored include:

a. Development of a single compatible software language or a language translator computer.

b. Development of a hardware interface between built-in test equipment and non-tactical computer systems.

c. Development of software programs that will properly interface the diverse systems.

Although these topics may go far beyond PME-107's parochial interests, it should be involved to an extent sufficient to protect those interests.

C. Final Note

Further study needs to be done in the area of maintenance reporting systems, because maintenance reporting systems impact several other systems and personnel considerations. Changes to the 3M system affect these systems and should be explored.

a. The Naval Supply System

Presently the supply system makes very little use of maintenance data because of its inaccuracies. However, with improvements underway, maintenance data could be influencial in determining stock levels, buy quantities, and allowance quantities. Therefore, a study to determine the impact of 3M improvements in these areas and/or the proper utilization of maintenance in these areas is appropriate.

b. Micro-circuitry maintenance

More and more equipment is being added to ships because of the continuing reduction of the size and weight of equipment due to micro-miniaturization. With this reduction in size has come a reduction in price and an increased difficulty of repair. The result is that more and more circuit boards have become throwaway parts with no repair attempted.

It has been suggested that repair is possible through miniature electronic repair. (1) At sea without benefit of higher level repair or possibly a spare circuit board, an equipment vital to the ship may be inoperable. Presently the ship has no capability to repair these boards.

Two areas of study suggest themselves:

a. Should the throwaway/turn-in policy of printed circuit boards be based on availability of repair rather than cost of repair?

b. Should the Navy expand organizational level repair on board ships to include micro-circuitry to provide the ship the alternative of repairing these boards?

c. Personnel policies

It has been highly publicized that today's high school graduate's reading ability is declining. At the same the sophistication of the Navy's equipment is increasing. Now with the addition of microprocessors,

that sophistication will penetrate many phases of Navy life.

1. How smart must the new sailor be to cope with the proliferation of microprocessors?
2. How will the proliferation of microprocessors affect training requirements and techniques?

d. PME-107

The final recommendation for study is a follow-on to this thesis, which includes a cost analysis of the various alternatives and recommendations and considerations for implementation.

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